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Response to Comment 3 in RC1

David Parrish

Community comment on "Long-term trend of ozone pollution in China during 2014–2020: distinct seasonal and spatial characteristics and ozone sensitivity" by Wenjie Wang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-123-CC1, 2022

Reply to 'Comment on acp-2022-123', Anonymous Referee #1, 24 Mar 2022

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We are grateful for the insightful and constructive comments provided by Anonymous Referee #1 of our paper (Wang et al., 2022). We plan to fully respond to all referee comments when we revise our paper following closure of the open discussion period. However, we wish to respond to the following comment by Referee #1 while the discussion is still open, so that posting of additional comments regarding this issue will be possible:

- Line 95-97: In general, the authors can do better in catching up the more recent studies of ozone trends and ozone sensitivity in China. An example here, there are also studies pointing out the increases in tropospheric ozone in northern mid-latitudes extend to more recent years (e.g. 2017) than 2000 (Cooper et al., 2020; Gaudel et al., 2020).

We believe that this comment misinterprets the results of the cited studies. Cooper et al. (2020), Gaudel et al. (2020) and a more recent paper (Chang et al., 2022), all including the same three lead authors, present careful linear trend analyses of a wide selection of tropospheric ozone data sets, all including measurements at northern midlatitudes, but covering somewhat different time periods. These three studies all utilize linear trend analyses to quantify the mean temporal trend over the past two to three decades included in the respective ozone measurements; thus they reveal the total net ozone change over that period, but do not provide information regarding how the ozone trend varied during that time. In contrast, Parrish et al. (2020) present a non-linear analysis of the northern midlatitude ozone changes over the past four decades; this non-linear analysis not only quantifies the net ozone change over that time period, but also provides additional information regarding variation of the ozone trend during that time. Table 1 compares the net trends quantified over four different time periods by the four analyses.

Overall, the results given in Table 1 agree that only small net changes have occurred in northern midlatitude ozone over the specified time periods; all derived trends are in the range of -1.14 to +1.41 ppb/decade. These trends are of significantly smaller magnitude than the net trends reported for earlier time periods; for example Logan et al. (2012) found that ozone over Europe increased by 6.5 to 10 ppb during the 1978–1989 period, and Cooper et al. (2010) report a strong increase of 6.3 ± 3.4 ppb/decade in springtime ozone across western North America during 1995–2008. The net trends in Table 1 are small because they reflect the overall ozone change due to the increases during the 1990's and early 2000s, and the decreases that followed the maximum concentrations reached in the mid-2000s (Parrish et al., 2020); the analyses presented in all four papers referenced in Table 1 are consistent with this picture. This non-linear character is also reflected in the analysis of Cooper et al. (2020), which found a negative trend of significantly greater magnitude for the 2000-2017 period, which included less of the early increase, compared to the 1995-2017 period.

We conclude that our original discussion on lines 95-97 in Wang et al. (2022) is correct: "The baseline ozone concentrations at northern midlatitudes increased at an average rate of ~ 0.60 ppb year^{-1} from 1980 to 2000 (Parrish et al., 2020)." However, as also reported by Parrish et al. (2020) that increase "… has ended, with a maximum reached in the mid☐2000s, followed by slow decrease (average = −0.09 ± 0.08 ppb year^{-1} from 2000 to the present)." The assertion of Referee #1 that increases in tropospheric ozone in northern mid-latitudes extend to more recent years (e.g. 2017) is not correct.

Table 1. Comparison of mean temporal trend derived from linear and non-linear trend analyses

Linear trend analysis reference	Time period	Mean linear trend (ppb/decade)	Mean trend from Parrish et al., 2020 (ppb/decade)[a]
Cooper et al., 2020	1995 - ~2017	-0.04 ± 0.22[b]	-0.24 ± 0.71
Cooper et al., 2020	2000 - ~2017	-0.54 ± 0.27[b]	-1.14 ± 0.94

Gaudel et al., 2020	1994 - 2016	+1.41 ± 0.16[c]	+0.12 ± 0.63
Chang et al., 2022	1994 - 2019	+0.04 ± 0.29[d]	-0.42 ± 0.75

[a] Calculated from the quadratic fit with the parameter values given in their Table 2 for all baseline data sets.

[b] Weighted mean of 12 northern midlatitude trends given in their Table 2. Each trend is weighted by the inverse square of the confidence limit reported for the trend.

[c] Weighted mean of 5 northern midlatitude trends given for the 950-250 hPa tropospheric ozone column in their Table S1a.

[d] Weighted mean of 15 northern midlatitude trends given in their Table 2.

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